Simulation Status for Pixels

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Where to find info

- **B-tau Web Page (I.Tomalin, F. Palla)**
  - http://cmsdoc.cern.ch/cms/Physics/btau/management/top/btau.html
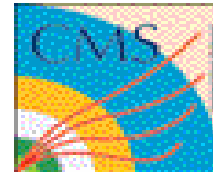- **Tracker Simulation and Geometry**
  - Coordinators: **Filippo Ambroglini** (University of Perugia, Italy)
    Neeti Parashar (Purdue University Calumet, USA)
- **Tasks:**
  - **TIB + TOB + TEC+ TID = Filippo**
  - **Barrels + Disks = NP**
    - **Geometry**
    - **SimHit**
    - **Digi**
- **Pixel offline group (chair. V.Chiochia/Uni.Zurich)**
  - **https://uimon.cern.ch/twiki/bin/view/CMS/PixelOfflineSoftware**
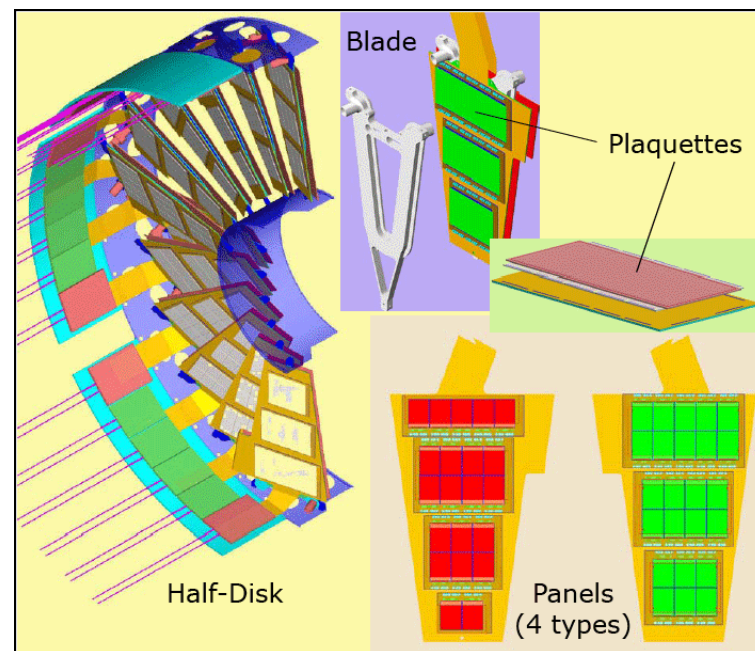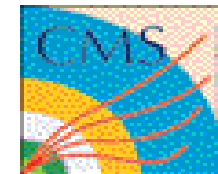
Forward Pixel Geometry

➢ **The forward pixels detector consists of two end-caps, with two *disks* for now**

➢ **Each disk contains 24 *blades*, made of an aluminum base**

➢ **Cooling channels of adjacent *blades* are connected by *nipples***

➢ **Each *panel* has a beryllium base plus HDI and three or four *plaquettes***

Pixel forward disks

Pixel barrel

Status
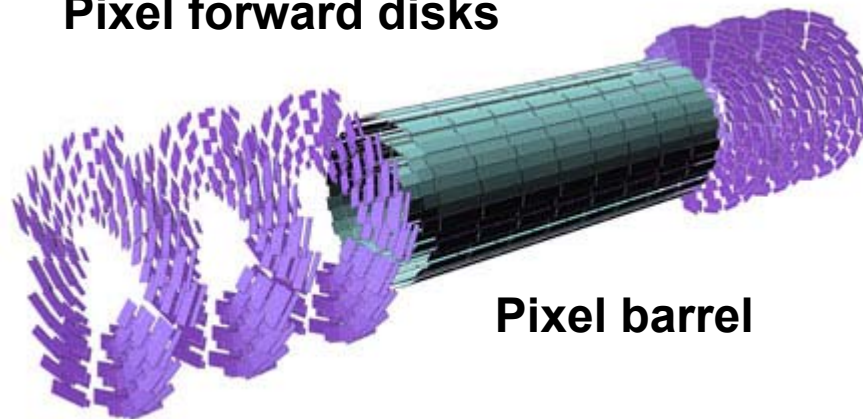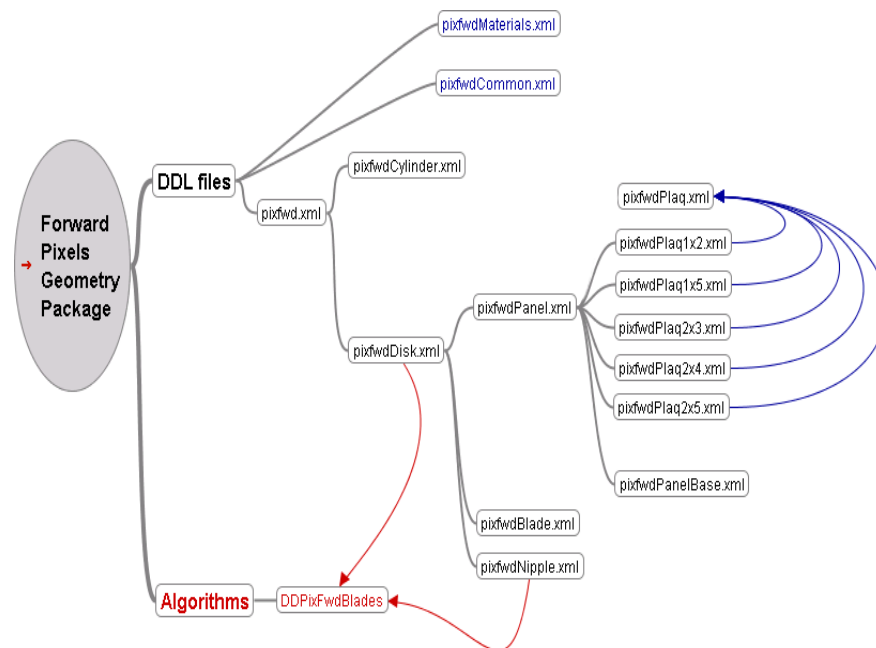
➢ **Detector Description Database used for simulation (OSCAR), reconstruction (ORCA), visualization, analysis..**

➢ **Files are written in XML**

➢ **Design of some of the components is not final**

- •Each file describes a subsystem

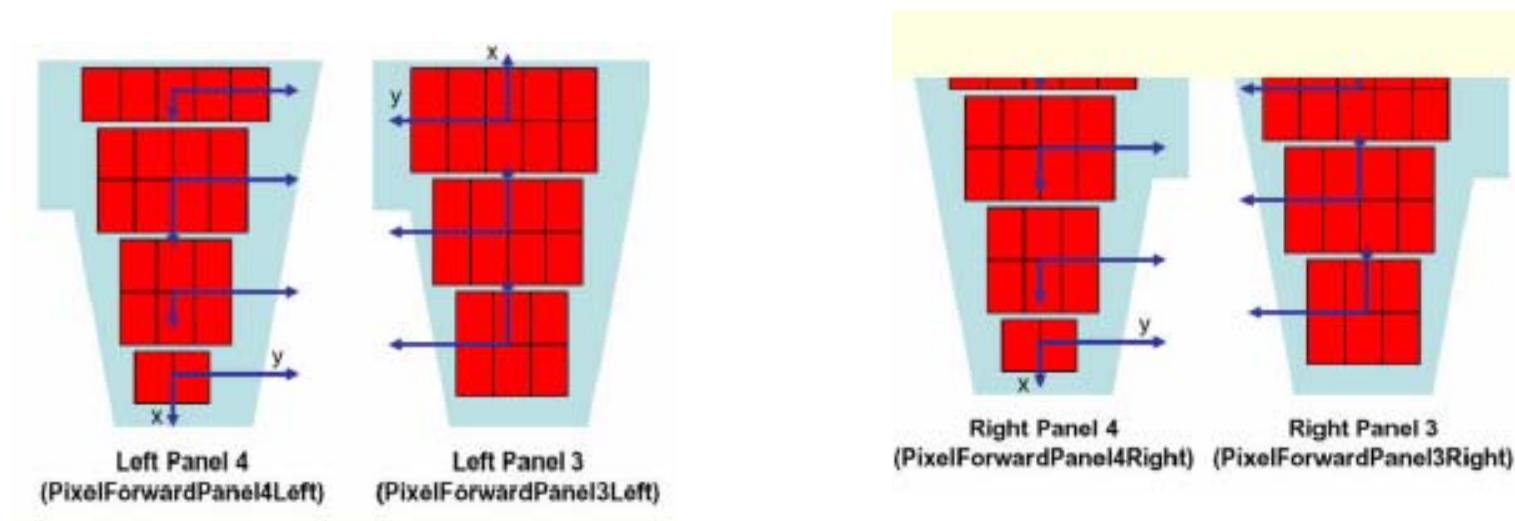- •Subsystems are positioned using coordinates of the anchor point

Each subsystem can be visualized and tested independently
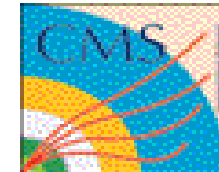
Some basic checks

➢ **Position and orientation of active detector areas have been checked for the Tracker - Complete!!!**

➢ **The pixel positioning comparison between engineers' drawings and simulation has already been done, both for barrel and forward pixel subdetectors**

➢ **The forward pixel plaquette local axis orientation has been revisited and updated**

Proposed new coordinate frames for FPIX geometry

Left Panel 4
(PixelForwardPanel4Left)

Left Panel 3
(PixelForwardPanel3Left)

Right Panel 4
(PixelForwardPanel4Right)

Right Panel 3
(PixelForwardPanel3Right)

Material Budget

- ➤ **Extensive work**
- ➤ **No source files found for FPIX**
- ➤ **Mixture program written**
- ➤ **Output implemented in XML**
- ➤ **Produce such a plot for the FPIX**

This is the actual integrated radiation length of the whole simulated Tracker as a function of pseudorapidity η
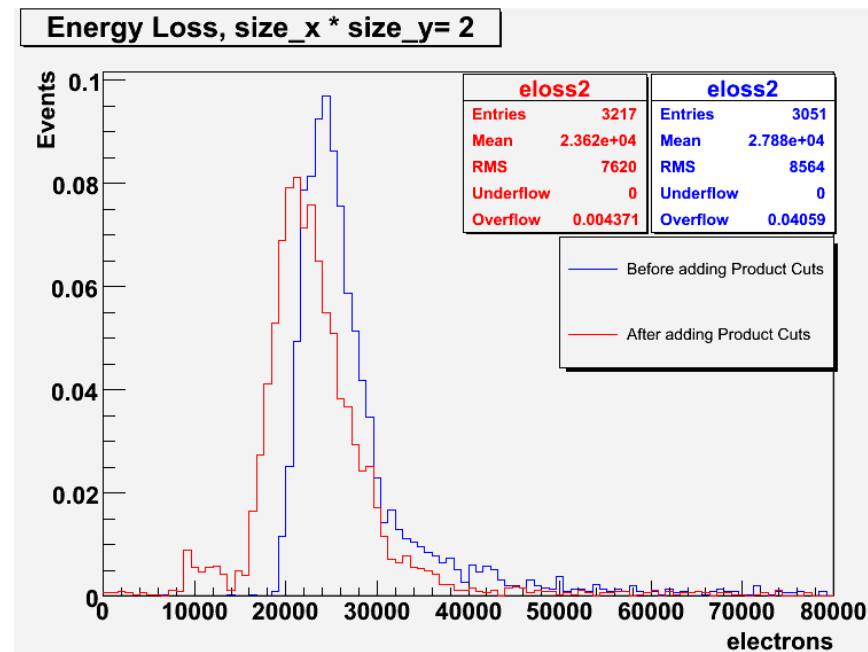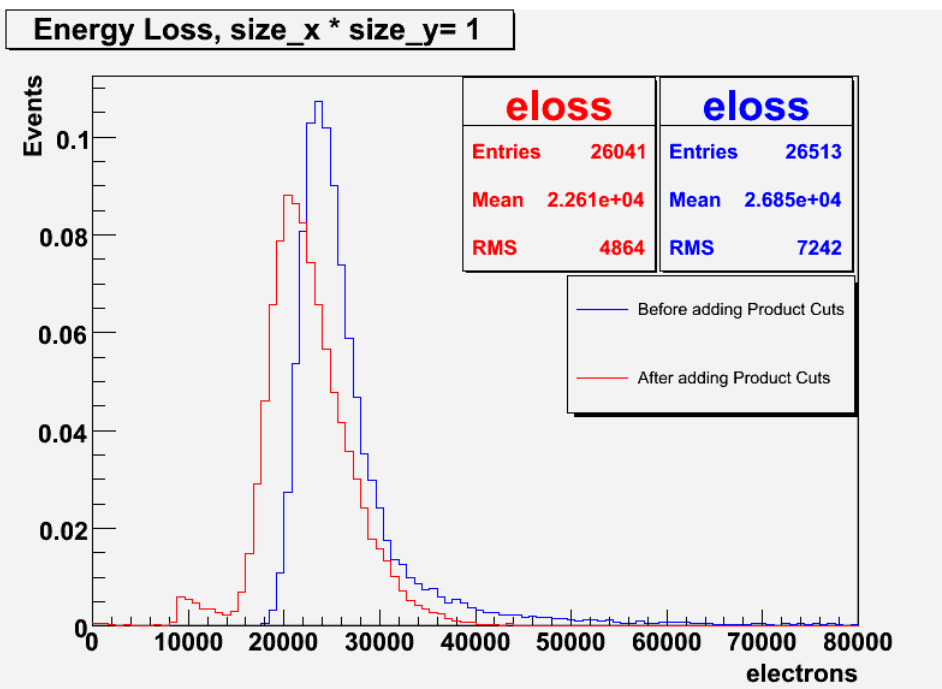

Tracker Material Budget
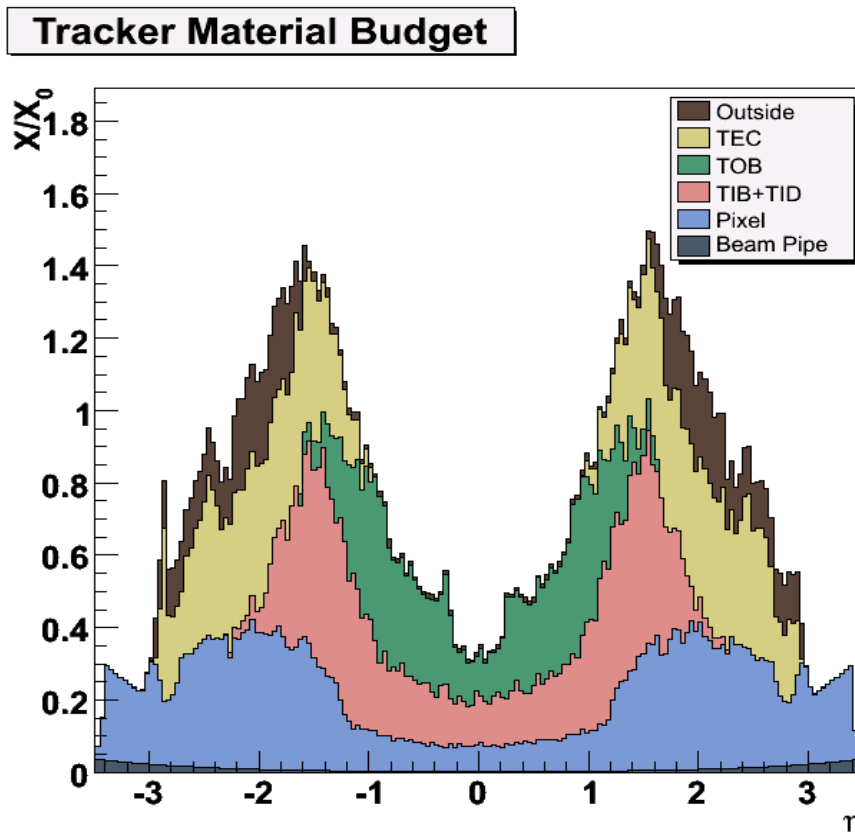
Geometry/TrackerCommonData/data/pixfwdMaterials.xml
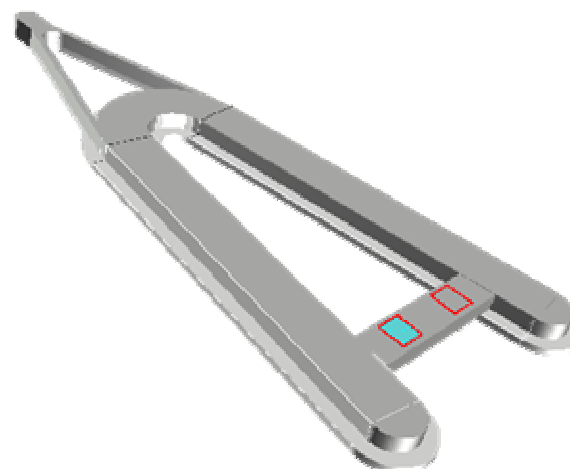Geometry/CMSCommonData/data/materials.xml
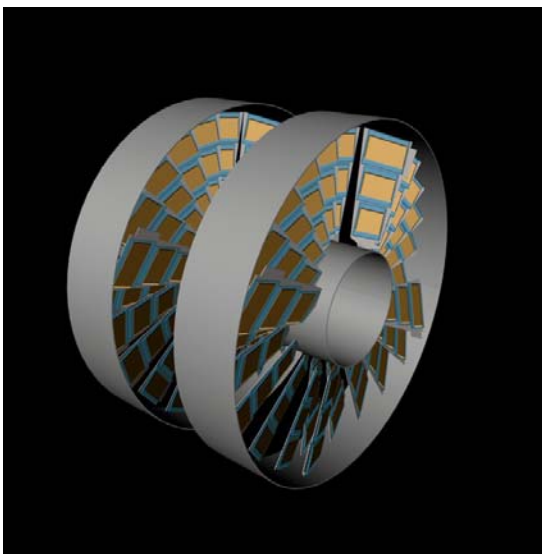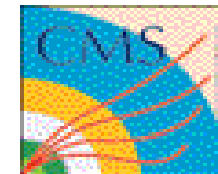
More FPIX Geometry changes
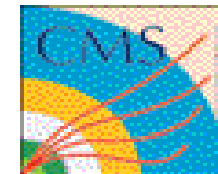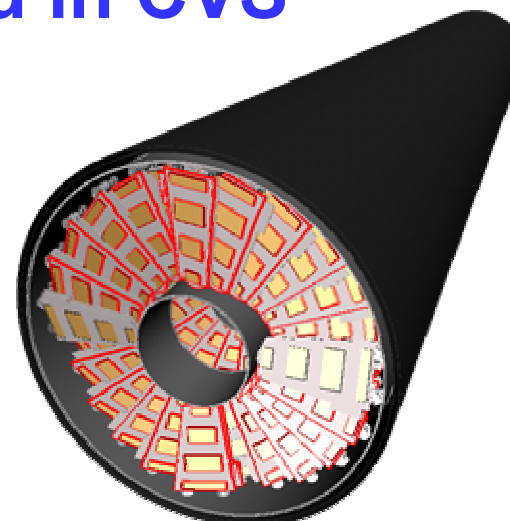
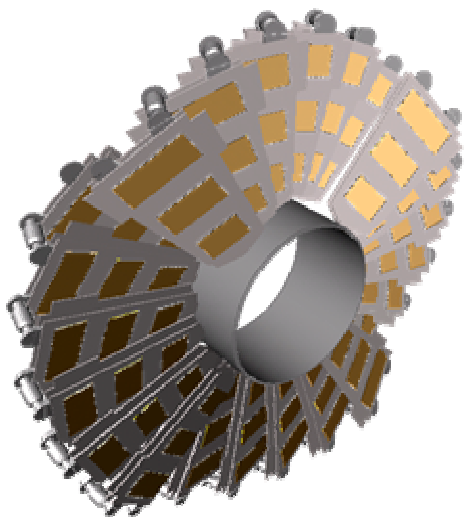"Geometry/TrackerSimData/data/trackerProductsCut.xml"

➢ **Energy loss of SimHits of one-pixel events**

➢ **Energy loss of SimHits of two-pixel events**

Visualization using IGUANA

Committed in CVS
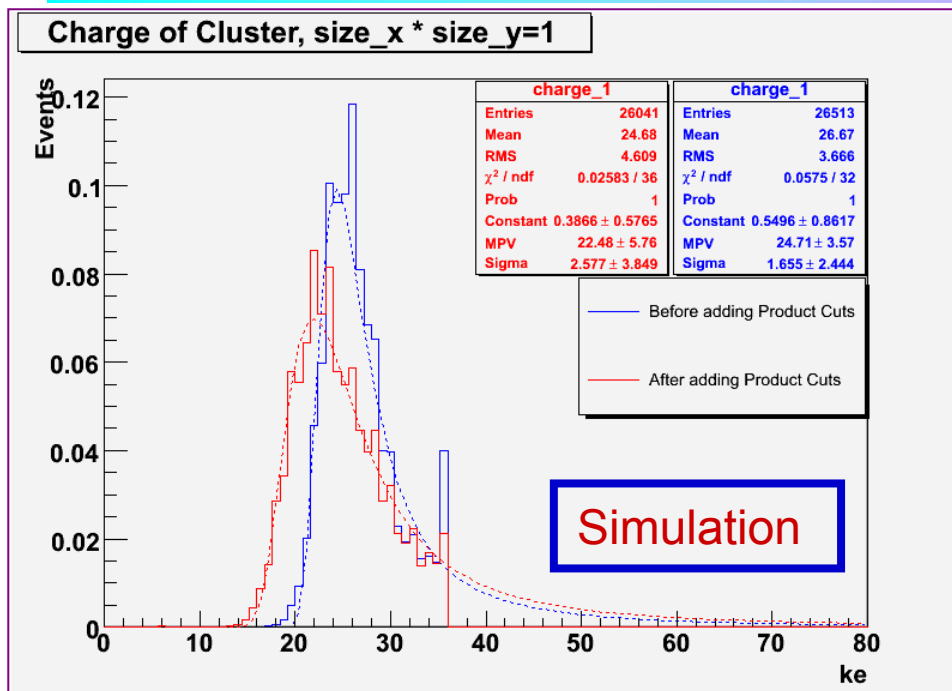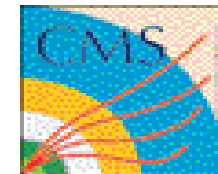
Tuning Simulation

- ➢ **Forward Pixel Test at FNAL**
  - ➢ **Non-CMSSW software was used to do physics analysis on the beam test**
    - ➢ **Efficiency after radiation**
    - ➢ **Charge cure for one-pixel events and two-pixel events**
    - ➢ **Resolution in x and y direction**
  - ➢ **Comparison between Simulation in CMSSW and Beam test showed some differences**
  - ➢ **The following changes in CMSSW were made:**
    - ➢ **Put product cuts for FPIX (missed earlier)**
    - ➢ **Implemented Mis-calibration (by Danek)**
    - ➢ **Some changes on the charge width in the reconstruction codes for simulation fpixel beam test special case.**
   - ➢ **No 20 degree rotation.**
      - ➢ **No magnetic field.**

GOOD AGREEMENT

Charge of 1 cluster

Charge of Cluster, size_x * size_y=1

	charge_1		charge_1
Entries	26041	Entries	26513
Mean	24.68	Mean	26.67
RMS	4.609	RMS	3.666
χ^2 / ndf	0.02583 / 36	χ^2 / ndf	0.0575 / 32
Prob	1	Prob	1
Constant	0.3866 ± 0.5765	Constant	0.5496 ± 0.8617
MPV	22.48 ± 5.76	MPV	24.71 ± 3.57
Sigma	2.577 ± 3.849	Sigma	1.655 ± 2.444

Before adding Product Cuts
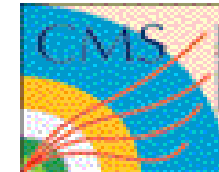
After adding Product Cuts

Simulation

One pixel events:
- Landau curve peaked at ~23k electrons, Γ~10k
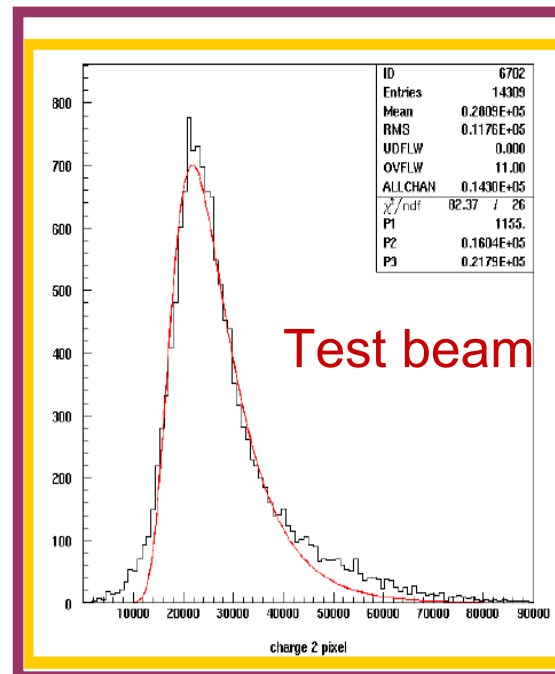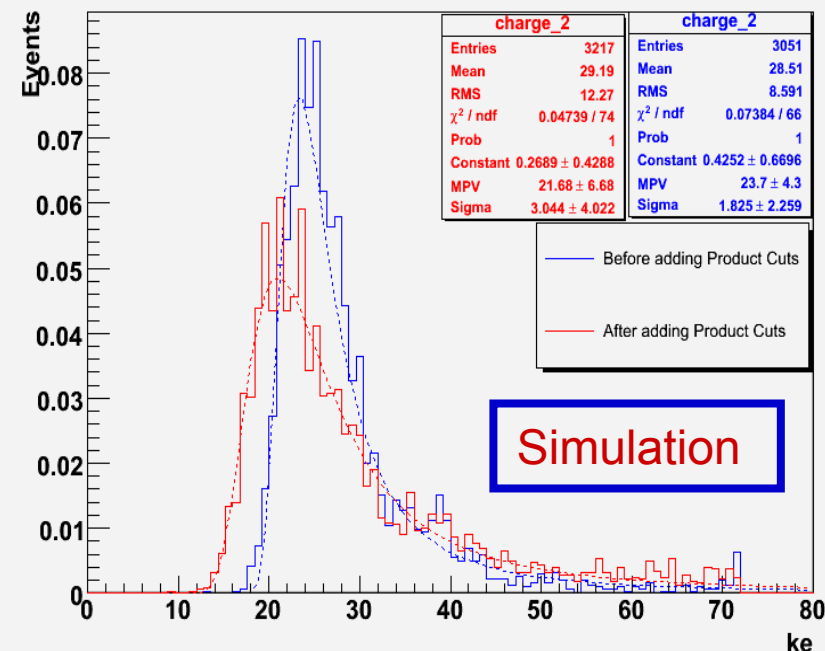 (scale factor:
      1 adc units = 60 electrons)

Test beam
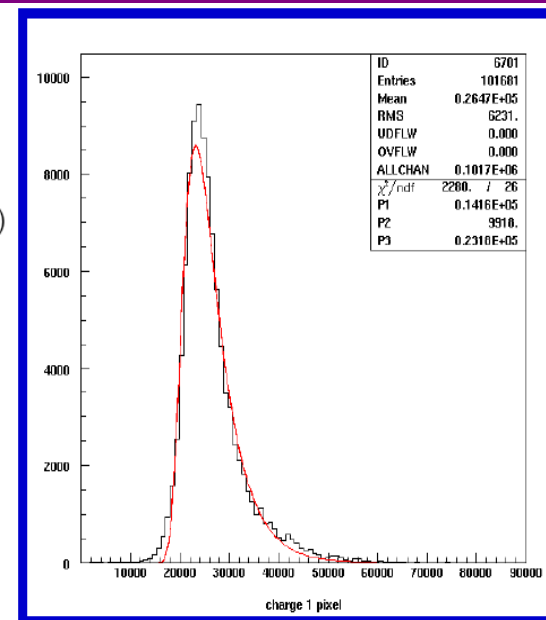
	Simulation (k electrons)	Test Beam (k electrons)
MPV	22.48	23.18
FWHM	11	10

Charge of 2 clusters

Charge of Cluster, size_x * size_y=2

charge_2
Entries 3217
Mean 29.19
RMS 12.27
χ^2 / ndf 0.04739 / 74
Prob 1
Constant 0.2689 ± 0.4288
MPV 21.68 ± 6.68
Sigma 3.044 ± 4.022

charge_2
Entries 3051
Mean 28.51
RMS 8.591
χ^2 / ndf 0.07384 / 66
Prob 1
Constant 0.4252 ± 0.6696
MPV 23.7 ± 4.3
Sigma 1.825 ± 2.259

Before adding Product Cuts

After adding Product Cuts

Simulation

Test beam

Two pixel events:
After using calibration we sum the charge of the 2 pixel.

- Landau curve peak at ~22k, Γ~16k electrons

- Peak consistent with that of one pixel.

- Γ is obviously wider

	Simulation (k electrons)	Test Beam (k electrons)
MPV	21.68	21.79
FWHM	13	16

Barrel Test Beam Analysis

➢ **Barrel Pixel Beam Test at CERN**

  ➢ **CMSSW to be used for physics analysis on the beam test data**

  ➢ **Comparison between simulation and beam test will be more useful**

  ➢ **Improve and tune pixel software at simulation , digitization and reconstruction levels**

Implementation of E.B. Effect

> **Digitization**

> **Reconstruction**

EB Effect in Digitization

> **Barrel Pixel**

> > **We know:** $\vec{E} \bullet \vec{B} = EB\cos\theta = 0$

> > **So the 2nd-order Lorentz drift is not important**

> **Forward Pixel**

> > **With 20 degree rotation wrt magnetic field,** $\vec{E} \bullet \vec{B} = EB\cos(20) \neq 0$

> > **There should be shift in both x and y**

> > > **~ - 2.8 μm in local x direction**

> > > **~ +/- 6.9 μm in local y direction**
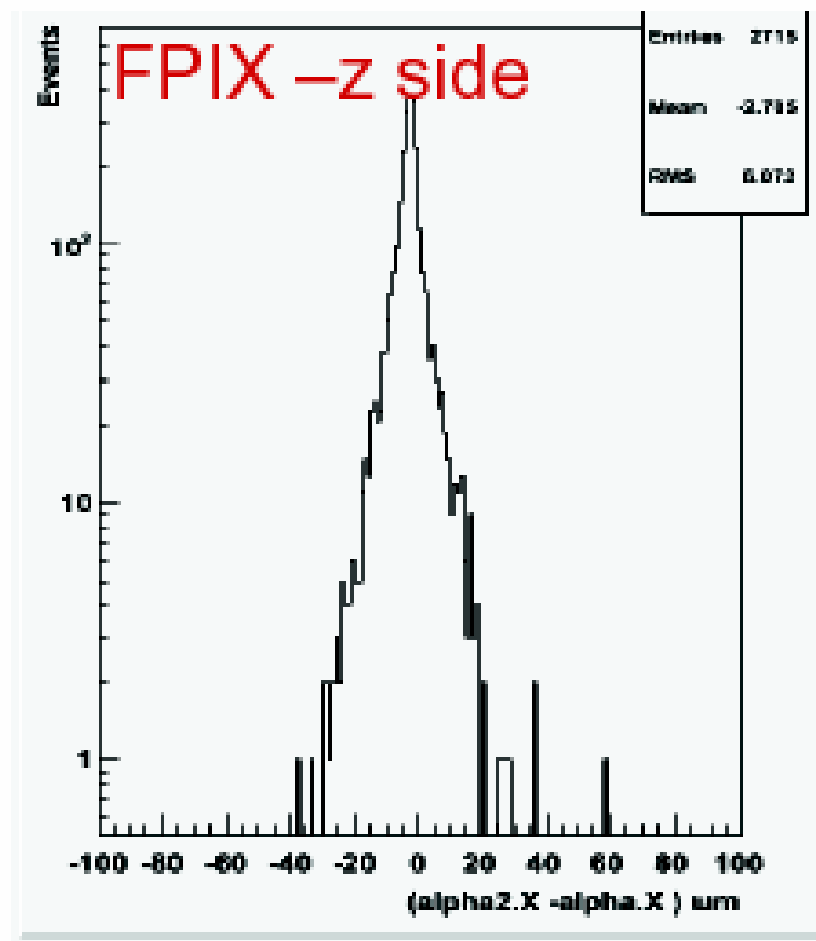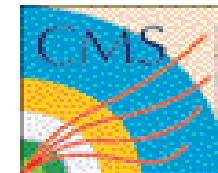
Mean shift along x
~-2.7μm
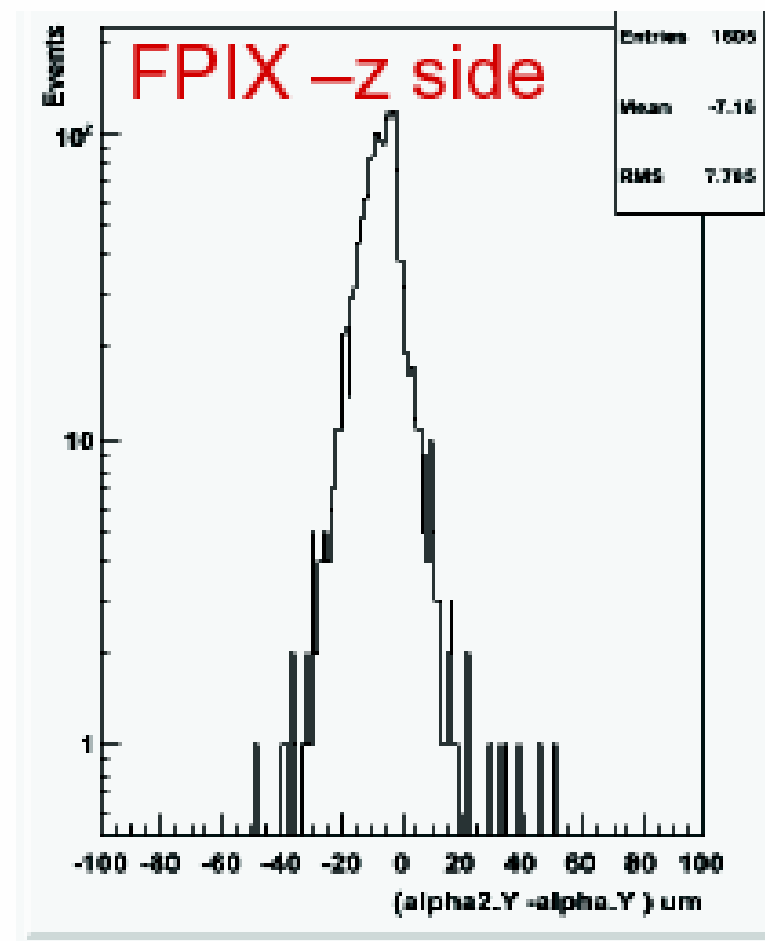
Mean shift along y
~-7.1μm

Correlation of Shift versus cluster size
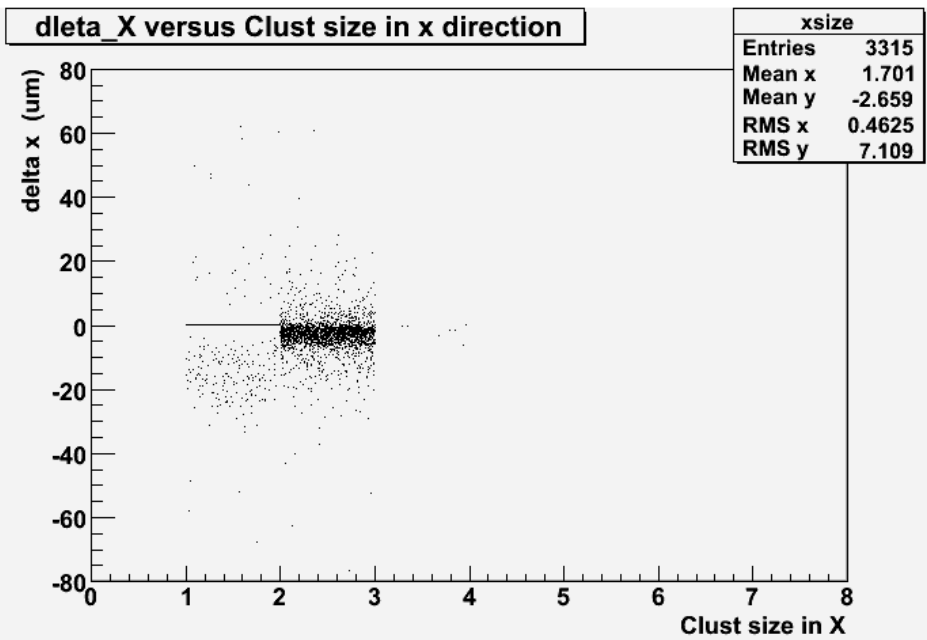
(X)
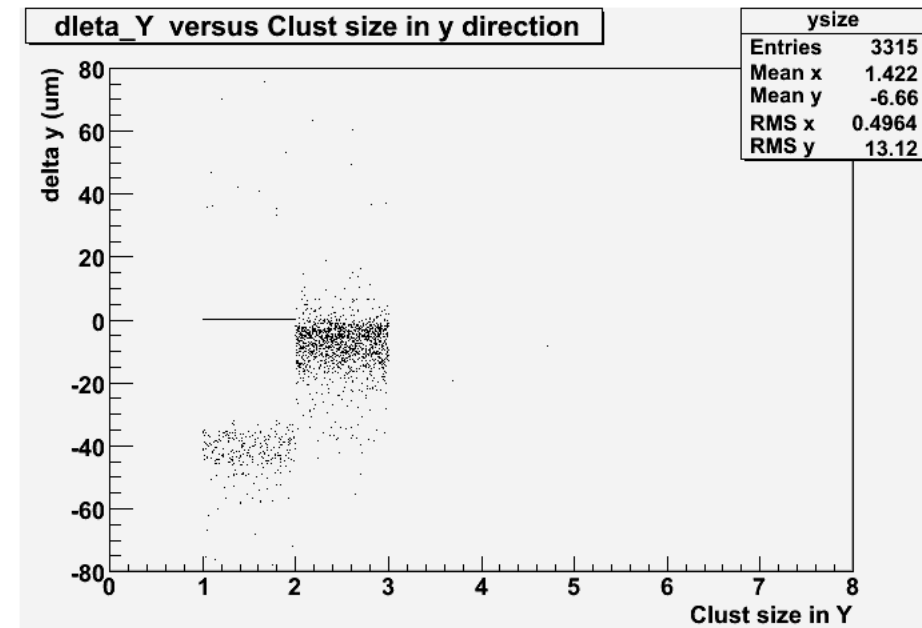
(Y)

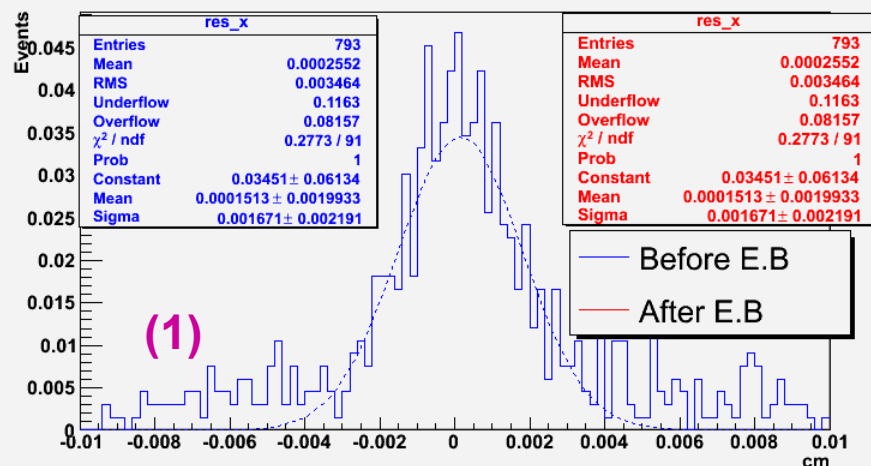➢ **the 2nd order Lorentz drift is more effective when cluster size > 1**

EB Effect in Reconstruction
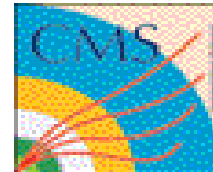
> ## Changes in SiPixelRechits Package

> > Add the 2nd order Lorentz drift (E·B)
> > Easily turn on /off via configuration file
> > Add a boolean flag to switch to the EB correction
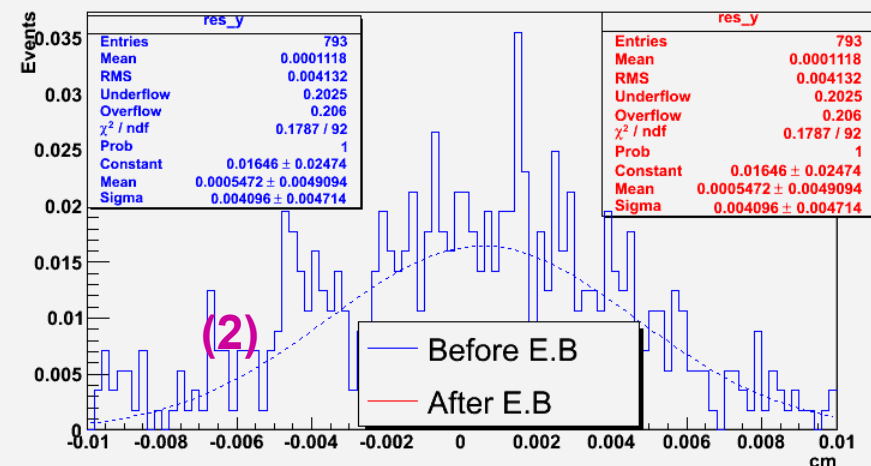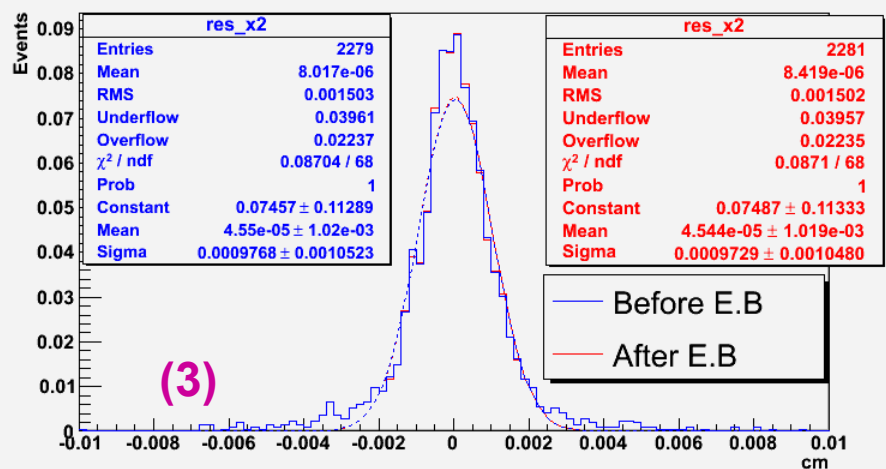> > Keep the current code unchanged

No effect on Barrel Pixel
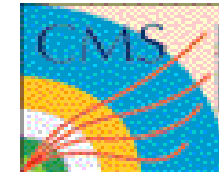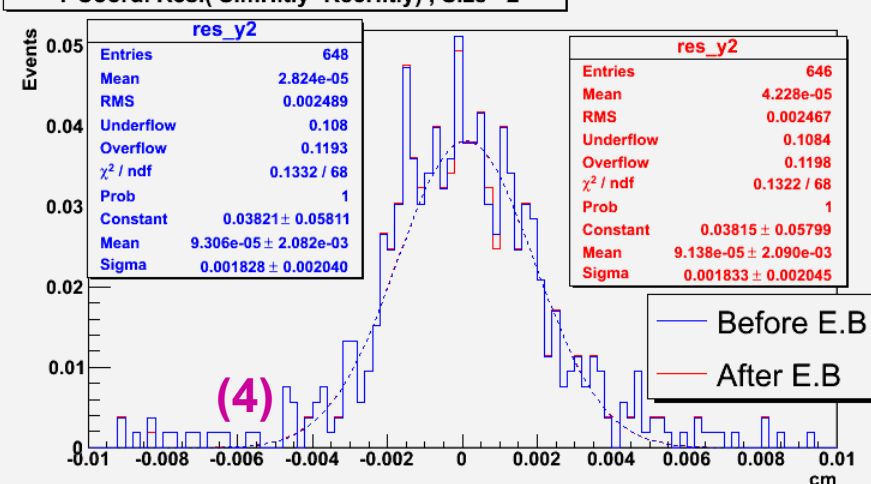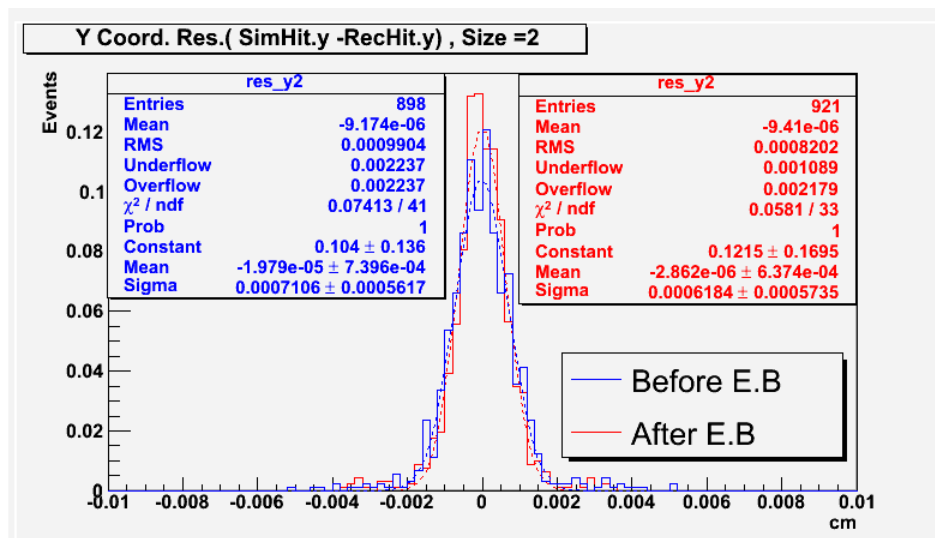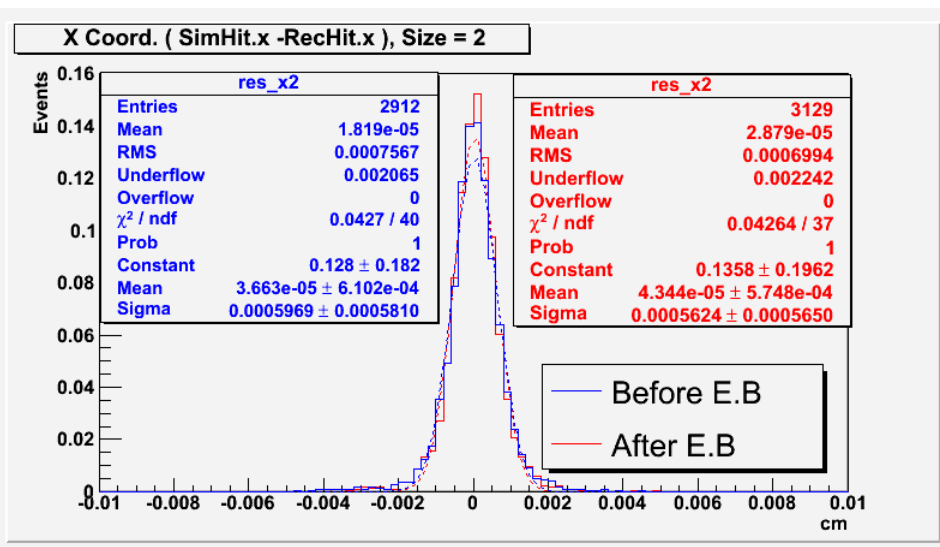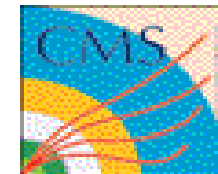
- ➢ σ$_x$=5.97 (Before E·B)
- ➢ σ$_x$=5.62 (After E·B)
- ➢ **5.8% improvement**

- ➢ σ$_Y$=7.10 (Before E·B)
- ➢ σ$_Y$=6.18 (After E·B)
- ➢ **12.9% improvement**
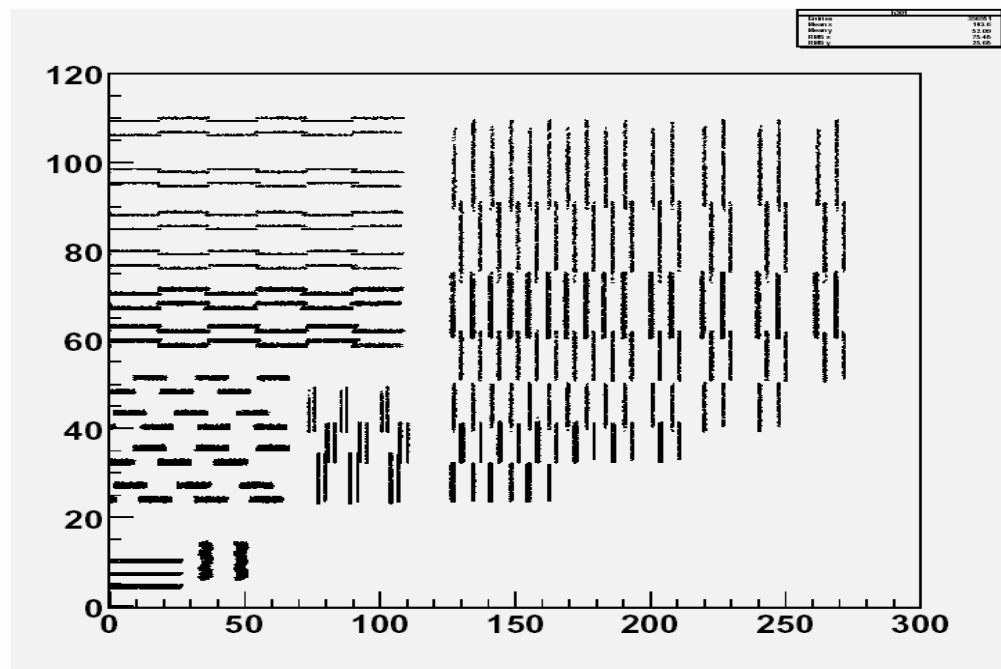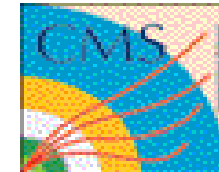
Tracker_FAMOS vs Tracker_OSCAR
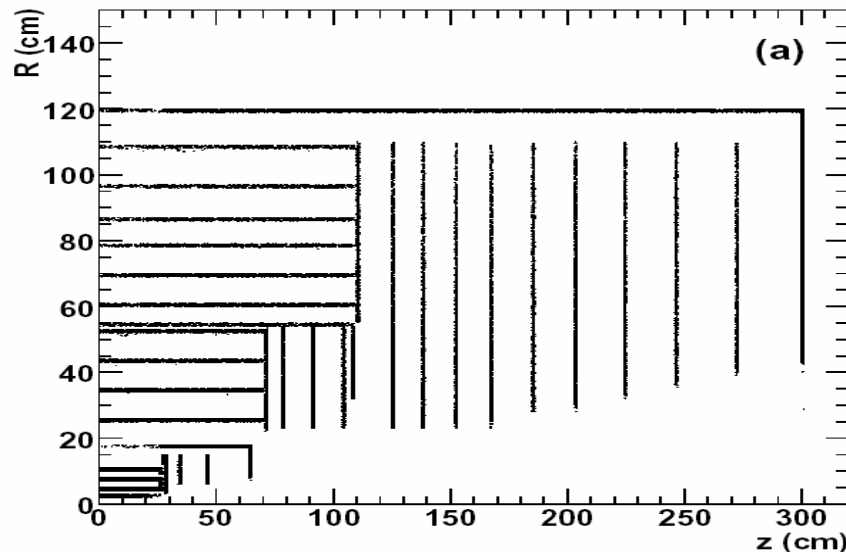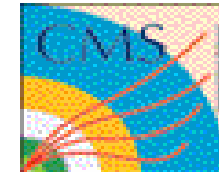
Tracker_FAMOS
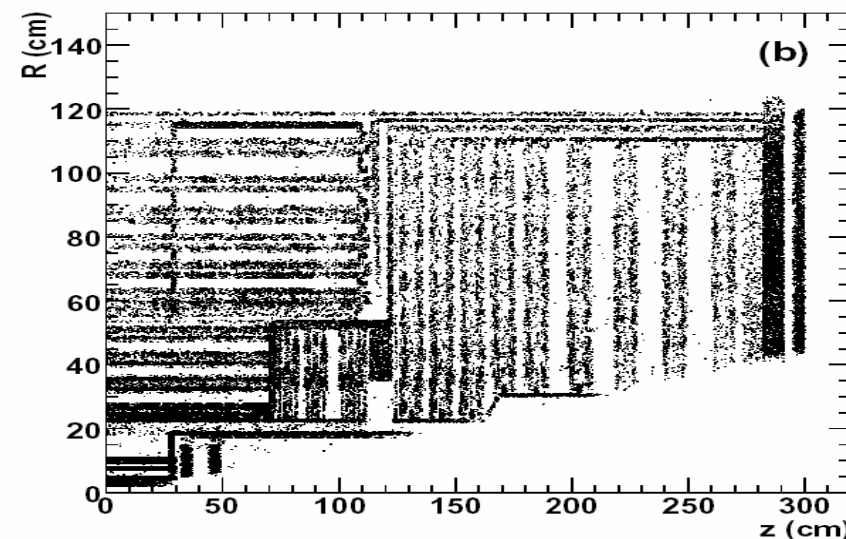
Tracker_OSCAR

➢ **Radiography of a quarter of the simulated tracker geometry**
➢ **(a): fast simulation (FAMOS)**
➢ **(b): full simulation (OSCAR)**

Tracker_CMSSW

➢**CMSSW version of FAMOS**

➢**Proper tracker geometry – active layers**

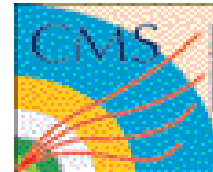➢**Provides a more realistic track reconstruction performance simulation**

➢ **Strips**

    ➢ **Done and tested, yet to be committed**

➢ **Pixels**

    ➢ **Just started**

    ➢ **Producing a macro file to read rootfile with the old data in FAMOS**

    ➢ **Use the same macro to read the rootfile with CMSSW**

Crew

➢ **Vesna Cuplov – Purdue University Calumet**

➢ **Xingtao Huang – University of Puerto Rico**

➢ **Max Bunce – University of Colorado**

➢ **Vincenzo Chiochia – University of Zurich**

➢ **Danek Kotlisnki – PSI**

➢ **Riccardo Ranieri - CERN**

➢ **Patrick Janot - CERN**

For suggestions/comments/volunteers

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